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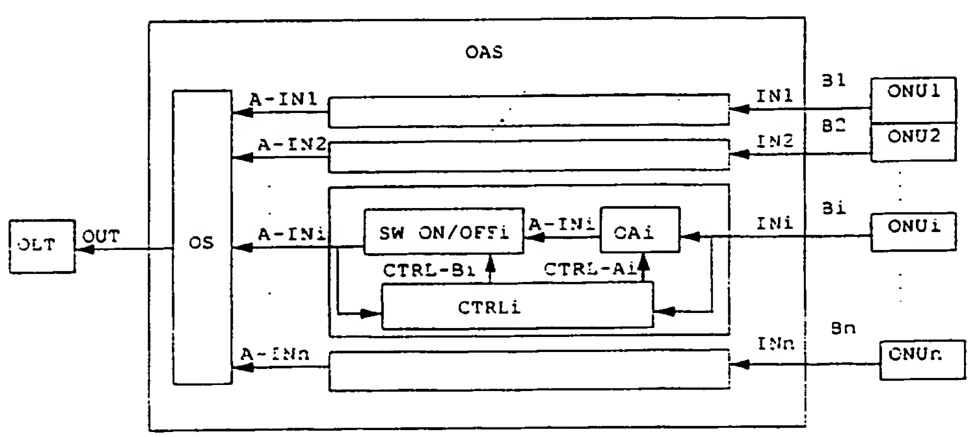
(54) Arrangement for amplifying and combining optical signals, and method for upstream transmission realised therewith

(57) The optical amplifier splitter arrangement is used in a tree-like optical network (APON) consisting of the cascade connection of dedicated branches, of the arrangement and of a common branch. The arrangement is coupled between a plurality of optical network users and an optical line terminator, via the dedicated branches and the common branch respectively. The network enables upstream transmission of information signals from the optical network users to the optical line terminator. The optical amplifier splitter arrangement includes for each branch of the dedicated branches :

- an optical amplifier to amplify an information signal with a gain value and to thereby generate an amplified information signal with a predetermined power level;
- an optical switch on/off coupled between the optical amplifier and an optical splitter to pass the amplified information signal when the information signal is present and to interrupt the branch when the information signal is not present. The optical splitter is included in the arrangement to combine all amplified information signals according to a multiple access technique and to thereby generate an outgoing optical signal for application to the optical line terminator.



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ure will be obvious to a person skilled in the art.

The optical amplifier splitter arrangement OAS is used in a tree-like optical network consisting of the cascade connection of dedicated branches B1, B2, ..., Bi, . Bn and of the optical amplifier splitter arrangement OAS and of a common branch. The optical amplifier splitter arrangement OAS is coupled between a plurality of optical network users ONU1, ONU2, ..., ONUi, ..., ONUn and an optical line terminator OLT via the above mentioned dedicated branches and common branch respectively.

The optical amplifier splitter arrangement OAS includes for each branch e.g. Bi, of the dedicated branches B1, B2,..., Bi, ..., Bn two basic parts :

- an optical amplifier OAi coupled to the respective netwotk user ONUi of the optical network users ONU1, ONU2, ..., ONUi, ..., ONUn; and
- an optical switch on/off SW ON/OFFi coupled between the optical amplifier OAi and an optical splitter OS.

The optical splitter OS is coupled between all optical switches on/off SW ON/OFF1, SW ON/OFF2, ..., SW ON/OFFi, ..., SW ON/OFFn which are simular to the optical switch on/off SW ON/OFFi and the optical line terminator OLT.

The optical amplifier splitter arrangement OAS enables upstream transmission in the optical network of information signals IN1, IN2, ..., INi, ... , INn from the optical network users ONU1, ONU2, ..., ONUi, ..., ONUn to the optical line terminator OLT.

The principle working of the optical amplifier splitter OAS will be explained in the following paragraph with respect to a signal INi transmitted over a branch Bi, the working with respect to the other branches being identical.

The optical amplifier OAi amplifies INi with a gain value Gi (not shown) and generates thereby an amplified information signal A-INi with a predetermined power level.

The optical switch on/off SW ON/OFFi passes the amplified information signal A-INi when it is present, but interrupts the branch Bi when the amplified information signal A-INi is not present.

The optical splitter OS combines all amplified information signals A-IN1, A-IN2, ..., A-INi, ..., A-INn simular to the amplified information signal A-INi according to a multiple access technique and generates thereby an outgoing optical signal OUT for application to the optical line terminator OLT.

In this embodiment the working of the optical amplifier OAi and the optical switch on/off SW ON/OFFi of each branch Bi is controlled by means of control means CTRLi. The control means CTRLi is coupled to the OAi and the optical switch on/off SW ON/OFFi and controls :

- the gain value Gi by means of a first electrical control signal CTRL-Ai composed of gain setting data GSi (not shown) and gain tuning data GTi (not shown); and
- the switch on/off SW ON/OFFi by means of a second electrical control signal CTRL-Bi.

The gain setting data GSi, the gain tuning data GTi and the second electrical control signal CTRL-Bi can be determined in different ways. A few particular implementations to determine them are described in a functional way in the following paragraphs, but they are not shown in the figure to avoid overloading thereof.

To determine the second electrical control signal CTRL-Bi, for each branch Bi, the control means CTRLi further includes power detection means which via an optical tap draws off the information signal INi a small power part. The power detection means determines whether the information signal INi is present or is not present and determines the second electrical control signal CTRL-Bi as a result thereof.

To determine the gain setting data GSi, for each branch Bi, the control means CTRLi further includes power measuring means. The same optical tap as above is used and the power measuring means measures the power of the information signal INi and determines the gain setting data GSi based thereon.

It has to be noted here, that to ensure that the power measuring means has enough time to fulfil its function, an optical delay line (not shown) is coupled between the optical tap and the optical amplifier OAi. The optical delay line delays the information signal INi untill the optical amplifier OAi is adjusted.

To determine the gain tuning data GTi, for each branch Bi, the control means CTRLi further includes additional power measuring means. Via an additional optical tap, coupled between the optical switch on/off SW ON/OFFi and the optical splitter OS a small power part is drawn off the amplified information signal A-INi and the additional power measuring means measures the power of the amplified information signal A-INi and determines the gain tuning data GTi based thereon.

Furthermore it is noted that although for the optical amplifier OAi an erbium doped fibre amplifier is used, semiconductor optical amplifiers are very good candidates to use in this implementation because of their low switch-on time. It is also remarked that these semiconductor optical amplifiers can be used to integrate the functions of the optical amplifier OAi and of the optical switch on/off SW ON/OFFi.

An alternative implementation to determine the second electrical control signal CTRL-Bi is realised for optical networks where the optical splitter OS combines the amplified information signals A-IN1, A-IN2, ..., A-INi, ... A-INn according to a time division multiple access technique. For such an optical network, the optical amplifier splitter arrangement OAS includes an optical network terminator NTOAM (not shown) for performing operation and maintenance functions. The NTOAM is coupled to the optical line terminator OLT, by means of also an additional optical tap, and to the control means

(Gi) by means of a first electrical control signal (CTRL-Ai) composed of gain setting data (GSi) and gain tuning data (GTi), and to control said switch on/off (SW ON/OFFi) by means of a second electrical control signal (CTRL-Bi).

3. Optical amplifier splitter arrangement (OAS) according to claim 2 characterized in, that for each said branch (Bi), said control means (CTRLi) further includes power detection means provided to detect whether said one information signal (INi) is present or is not present and to determine said second electrical control signal (CTRL-Bi) as a result thereof.

4. Optical amplifier splitter arrangement (OAS) according to claim 2 characterized in that said optical splitter (OS) is provided to combine said amplified information signals (A-IN1, A-IN2, ..., A-INi, ..., A-INn) according to a time division multiple access (TDMA) technique, and in that said arrangement (OAS) also includes an optical network terminator (NTOAM) for performing operation and maintenance functions and which is coupled to said optical line terminator (OLT) and said control means (CTRLi), said optical network terminator (NTOAM) being included to capture special grant information out of downstream signals sent from said optical line terminator (OLT) to said optical network users (ONU1, ONU2, ..., ONUi, ..., ONUn) and to apply said special grant information to said control means (CTRLi) to thereby enable said control means (CTRLi) to determine whether said information signal (INi) will be present or not present within a predetermined time interval and to determine said second electrical control signal (CTRL-Bi) as a result thereof.

5. Optical amplifier splitter arrangement (OAS) according to claim 2 characterized in that for each said branch (Bi) said control means (CTRLi) further includes power measuring means provided to measure the power of said one information signal (INi) and to determine said gain setting data (GSi) based thereon.

6. Optical amplifier splitter arrangement (OAS) according to claim 2 characterized in that, for each said branch (Bi), said control means (CTRLi) further includes power measuring means provided to measure the power of said amplified information signal (A-INi) and to determine said gain tuning data (GTi) based thereon.

7. Optical amplifier splitter arrangement (OAS) according to claim 2 characterized in that, for each said branch (Bi), said control means (CTRLi) further includes power measuring means provided to measure the power of said amplified information signal (A-INi) and to provide a value of measured power of said amplified information signal (A-INi) and further includes memory means to memorize said value, said value being used to determine said gain tuning data (GTi) for a following transmitted information signal (INi).

8. Optical amplifier splitter arrangement (OAS) according to claim 2 characterized in that said arrangement (OAS) also includes a power level unit (P-opt) coupled between a control output of said optical splitter (OS) and said control means (CTRLi) associated with each branch (Bi), said power level unit being (P-opt) provided to measure the power level of said outgoing optical signal (OUT) and to supply as a result thereof electrical power level data (P-OUT) to said control means (CTRLi) to thereby enable said control means (CTRLi) to determine said gain tuning data (GTi) when said information signal (A-INi) is present.

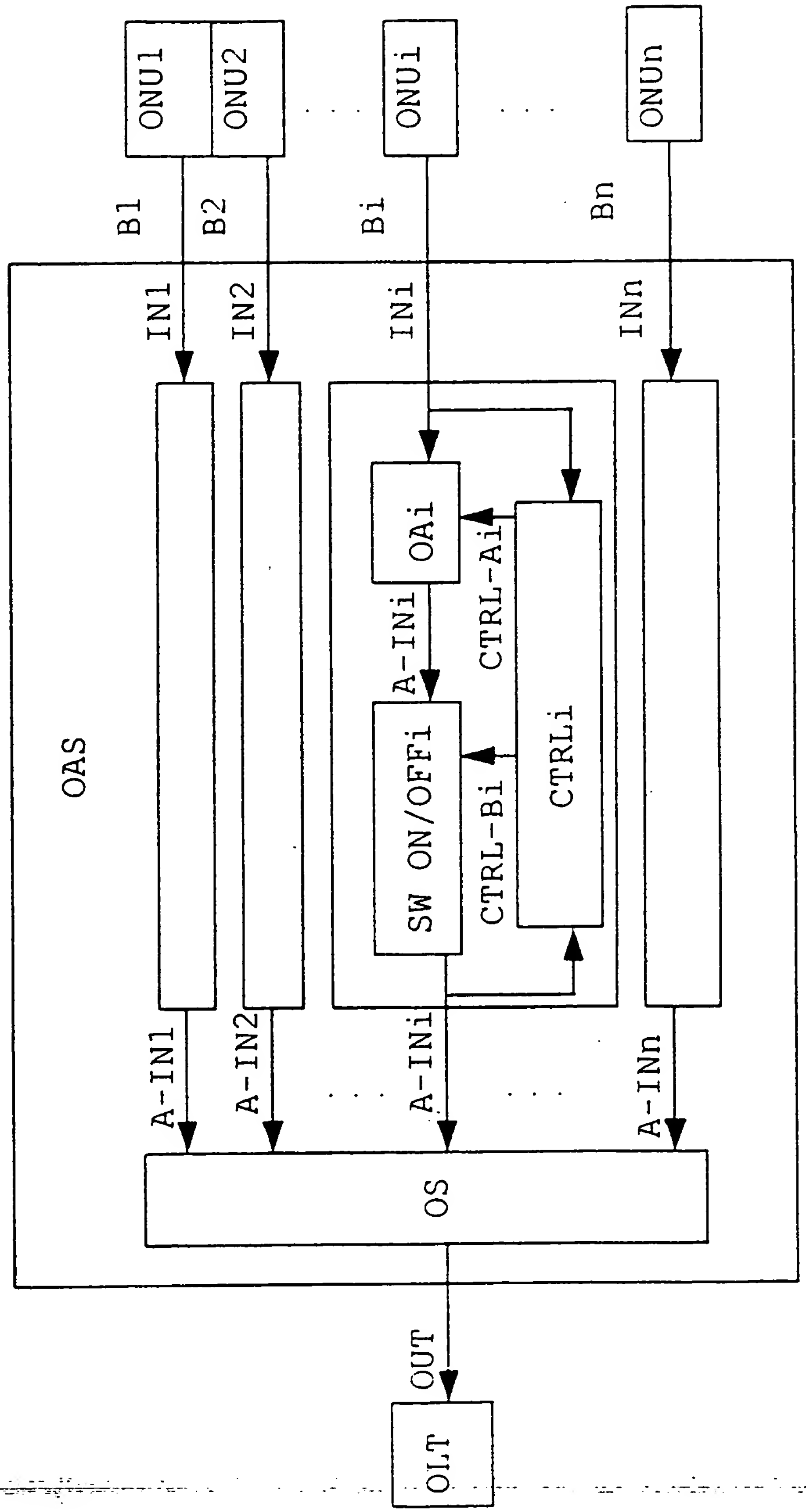
9. Optical amplifier splitter arrangement (OAS) according to claim 1 characterized in that said optical splitter (OS) and all optical switches on/off (SW ON/OFF1, SW ON/OFF2, ..., SW ON/OFFi, ..., SW ON/OFFn) simular to said optical switch on/off (SW ON/OFFi) are integrated in an optical switch (OSW).

10. A method used in a tree-like optical network (APON) to perform upstream transmission of information signals (IN1, IN2,..., INi, ..., INn) from a plurality of optical network users (ONU1, ONU2, ..., ONUi, ..., ONUn) to an optical line terminator (OLT) via dedicated branches (B1, B2,..., Bi, ..., Bn) and a common branch respectively, characterized in that said method for each one (INi) of said information signals (IN1, IN2, ..., INi, ..., INn) comprises the steps of :

a. amplifying said information signal (INi) and thereby generating an amplified information signal (A-INi);
b. passing said amplified information signal (A-INi) when said information signal (INi) is present and interrupting said branch (Bi) when said information signal (INi) is not present;

and further includes the step of :

c. combining all amplified information signals (A-IN1, A-IN2, ..., A-INi, ..., A-INn) simular to said amplified information signal (A-INi) according to a multiple access technique thereby generating an outgoing optical signal (OUT) which is transmitted to said optical line terminator (OLT).


ONU1
ONU2
ONUi
ONUn
B1
B2
Bi
Bn
IN1
IN2
INi
INn
OAS
OAi
CTRL-Ai
A-INi
CTRLi
SW ON/OFFi
CTRL-Bi
A-IN1
A-IN2
A-INi
A-INn
OS
OUT
OLT

INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR
STUDY PERIOD 1997 - 2000

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STUDY GROUP 15 – CONTRIBUTION 109

SOURCE*: RAPPORTEUR OF QUESTION 2/15

TITLE: PROPOSED NEW RECOMMENDATION OF ONT/NT MANAGEMENT AND CONTROL INTERFACE FOR G.983 ATM-PON

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1. Introduction

This document proposes a new Recommendation, G.983.omci, that specifies the ONT/NT Management and Control Interface for the ATM-PON system to enable multi-vendor interoperability between the OLT and the ONT/NT defined in the ATM-PON Recommendation G.983.

This white contribution is submitted to provide an initial input on the new Recommendation G.983.omci and to accelerate the discussion in the next, October, meeting of SG15 in Geneva. This white contribution is not a complete specification, and further additions will be submitted as a delayed paper to the October meeting, and as a white contribution to the meeting that follows the October one.

The OMCI specification presented in this document, when completed, will consist of the following three parts:

1. The ONT/NT Management and Control MIB (Management Information Base);
2. The ONT/NT Management and Control Channel (OMCC);
3. The ONT/NT Management and Control Protocol and detailed messages.

The proposed specification has been discussed and agreed to by a correspondence group of Q2/15, especially a group of multinational operators and suppliers of telecommunication equipment and systems, named FSAN(**).

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** FSAN group includes Bell Canada, BellSouth, BT, Telecom Italia/CSELT, DTAG, France Telecom, GTE, Korea Telecom, NTT, SBC, Swisscom, Telefonica, Telstra, Alcatel, Ascom, BBT, Bosch Telecom, Ericsson, Fujitsu, Italtel, Lucent Technologies, NEC, Nortel, SAT and Siemens.

2. Discussion

In the broadband access network specified by FSAN, the OLT manages and controls network terminations such as ONT and NT, i.e., it manages their configuration, faults, performance, and security. It is useful to standardize the interface between the OLT and the ONT/NT while taking into account the following three viewpoints.

(1) ONT/NT Management and Control Channel (OMCC)

A point-to-point ATM VP connection between the OLT and each ONT/NT serves as the OMCC.

(2) ONT/NT Management and Control Protocol

As simple a protocol as possible is the goal. The Simple Device Protocol (SDP), which uses one-cell long messages , has been proposed and discussed in the ATM Forum. This document proposes to adapt this protocol for the system specified in ITU-T Rec. G.983.

(3) ONT/NT Management and Control Information Model

This document proposes to adapt a simplified protocol-independent MIB (Management Information Base) that has as much commonality with other ITU-T Recommendations as possible. This makes the ONT/NT Management and Control Interface simple while maintaining commonality with the MIB for the Q3 interface between the network-element manager and the OLT.

3. Proposal

The proposed ONT/NT Management and Control Interface Specification is attached as Annex A. A list of contents of the Recommendation shows the study items. Proposals for Sections 1, 2, 3, 8 and 9.1 are included in this contribution; the missing parts require further study and will be provided in a delayed contribution at the next meeting.

Further contributions are welcomed to accelerate the discussions.

ANNEX A

1. Scope of This Document

1.1 Introduction

This document specifies the ONT/NT Management and Control Interface (OMCI) to enable multi-vendor interoperability between the OLT and the ONT/NT.

The OMCI specification described in this document consists of the following three parts:

1. The ONT/NT Management and Control Management Information Base (MIB);
2. The ONT/NT Management and Control Channel (OMCC);
3. The ONT/NT Management and Control protocol and detailed messages.

1.2 OMCI in the ITU-T Rec. G.983 System

Note that the terminology used in this document is not always the same as the terminology used by the broad-range ITU-T Rec. G.983 documents. Table 1 is provided to assist the reader in understanding the mapping between these terms.

Table 1: Mapping of Equivalent Terms

Commonly Used Equivalent	Term used in this document
ONU in the FTTH configuration	ONT
ONU in the FTTB, FTTC and FTTCab configurations	ONU
NT in the FTTB, FTTC and FTTCab configurations	NT

The OMCI specification fits into the overall ITU-T Rec. G.983 model for an access network system as illustrated in Figure 1.

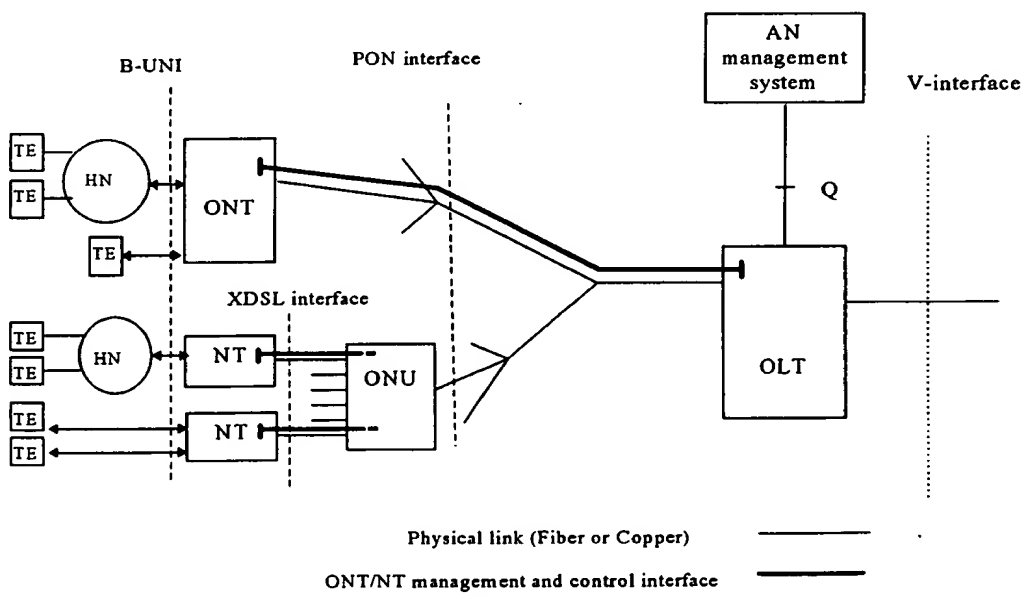


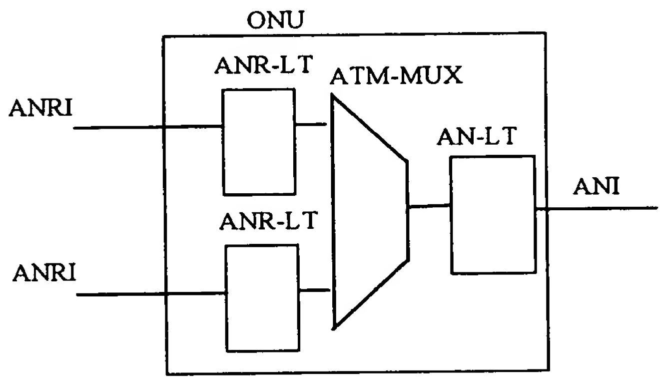
Figure 1 Reference configuration

1.2.1 ONU

The ONU functions are:

(1) Access network line termination function (AN-LT)
This function terminates the access network line, i.e., the PON interface
(2) Access network repeater line termination function (ANR-LT)
This function terminates the access network repeater line, e.g., . an xDSL interface.
(3) ATM multiplexer and demultiplexer function (ATM-Mux)
This function provides ATM connections between the AN-LT and the ANR-LTs.

Figure 2 ONU functional diagram



1.2.2 ONT

The ONT functions are:

(1) Access network line termination function (AN-LT)
This function terminates the access network line, i.e., the PON interface
(2) User network interface line termination function (UNI-LT)
This function terminates the user/network interface line.
(3) ATM multiplexer and demultiplexer function (ATM-Mux)
This function provides ATM connections between the AN-LT and the UNI-LTs.

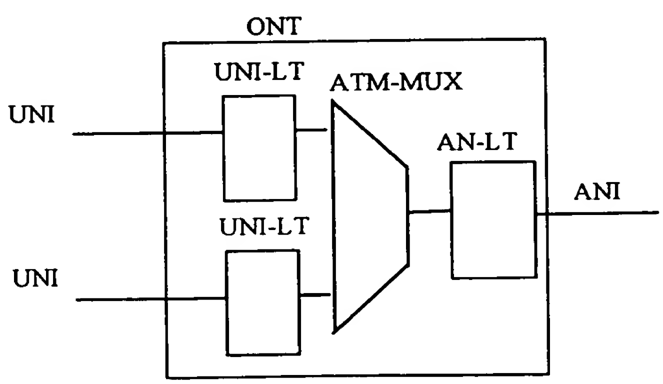


Figure 3 ONT functional diagram

1.2.3 NT

The NT functions are :

(1) Access network repeater line termination function (ANR-LT)
This function terminates the access network repeater line, e..g., an xDSL interface.
(2) User/network interface line termination function (UNI-LT)
This function terminates the user/network interface line.
(3) ATM multiplexer and demultiplexer function (ATM-Mux)
This function provides ATM connections between ANR-LT and UNI-LTs.

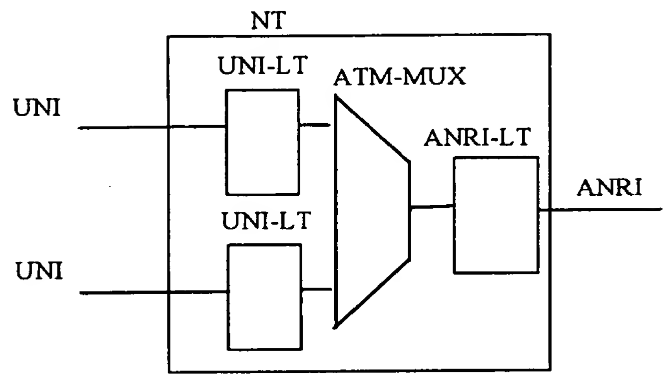


Figure 4 NT functional diagram

1.2.4 ONT vs. ONU

The ONU is a complex network element, requiring some intelligence to execute the functions it supports (different operators may prescribe different functions).

While the interface between the ONU and the OLT in Figure 1 looks similar to the one between the ONT and the OLT, one has to recognize that the ONU, by definition, is more complex than the ONT and implements more functionalities. Even though the physical layers of the PON interfaces for the ONU and ONT are functionally identical up to and including the ranging procedure, their management interfaces are different. Because of this, the definition of the ONU/OLT management interface requires more work and is not addressed in this document.

1.2.5 ONT vs. NT

The ONT and NT have the same UNI interface requirements. They have the same requirements regarding security, traffic priorities, reliability and other features. They only differ in physical layer functions towards the access distribution network.

The ONT and NT are logical peripherals of the OLT and the ONU, respectively. Most of ONT/NT intelligence depends on OLT/ONU. Hence it makes sense to follow a common approach for their management.

The ONT/NT management interface should be defined to allow vendors to offer modular, incremental capabilities to meet different levels of customer needs. This specification first targets low-cost ONT/NTs. It defines the simplest protocol necessary to support capabilities identified by the ITU-T Rec. G.983 as important for early deployment and interoperability, yet allows for optional components and future extensions.

1.2.6 VP-MUX Only ONT/NT

Note that the ITU-T Rec. G.983 ATM-PON system as a whole (OLT and ONT/NT) can function as an ATM cross-connect with both provisioned and on-demand connectivity. The configuration of the ATM cross-connect can be initiated independently by

1. The network element operations system via the management interface (e.g. Q3), or
2. The Service Node (SN) over a VB5.2 Broadband Bearer Connection Control (B-BCC) signaling.

The ONT/NT, however, always acts as a provisioned ATM multiplexer. The OMCI itself does not distinguish between these two cases except that in the on-demand case a fast reaction time of the OMCI is required.

Also note that even though the ITU-T Rec. G.983 system as a whole (OLT and ONT/NT) can function as a VP as well as a VC switch, the low-cost ONT/NT addressed in this specification multiplexes/demultiplexes ATM connections on the VP level only, i.e., only VPI translation is supported in the ONT/NT.

2. Requirements of the management interface specification

The OMCI uses a general-purpose protocol to control an ONT/NT and allows the OLT to:

1. Establish and release connections across the ONT/NT;
2. Manage the UNIs at the ONT/NT;
3. Request configuration information and performance statistics;
4. Autonomously inform the system operator of events such as link failures.

The OMCI protocol runs across an ATM connection between the OLT controller to the ONT/NT controller that is established at ONT/NT initialization. The OMCI protocol is asymmetric: the controller in the OLT is the master, and the one in the ONT/NT is the slave. Multiple ONTs may be controlled by a single OLT controller using multiple instantiations of the protocol over separate control channels.

The ONT/NT management and control interface requirements given in this document are needed to manage the ONT/NT in the following areas:

1. Configuration;
2. Fault;
3. Performance, and
4. Security.

2.1 Configuration management

Configuration management provides functions to exercise control over, identify, collect data from and provide data to the ONT/NT. This involves the following:

1. Configuration of the equipment
2. Configuration of the UNIs
3. Configuration of the ATM VP Link Termination Points and Cross-Connections
4. Configuration of interworking VCC terminations (non-ATM UNIs only)
5. Configuration of the OAM Flows
6. Configuration of the physical ports

2.2 *Fault management*

The ONT/NT suppors limited fault management only. Most of the operations are limited to failure indication. The managed entities in sections 0-**Error! Reference source not found.** that are required to support the following failure-reporting functions:

1. ONT/NT
2. UNI cards
3. Physical Path Termination Points
4. TC Adaptors
5. Interworking VCC Termination Points
6. Software
7. VPL Termination Points.

An alarm table, based on related standards specified by ITU-T, ATMF, etc., is defined for each of these entities. The ONT informs the OLT of alarm status changes by sending alarm status change notifications. Note that these notifications are sent in unacknowledged messages which carry sequence numbers for the OLT to detect lost messages, see the next paragraph.

Each alarm message carries an 8-bit sequence number that is incremented with each message modulo 255. When the OLT detects a gap in the received sequence, it asks the ONT/NT for an alarm status report by sending an alarm status reading command. Obviously, this command is acknowledged by a response that contains the alarm status. The OLT compares the received report with the copy of the alarm status for that ONT/NT in its memory and informs the network element manager of any differences between the two.

The following code is used for alarm on/off:

Coding	Contents	Description
0	off	alarm is not active
1	on	alarm is active

The ONT/NT shall also support selective OAM cell loop-back testing at the UNI. The ONT/NT diagnostics is limited to ONT/NT self test. The OLT or element manager will process the information from the ONT/NT, for example, the OLT/EM will determine the severity of each alarm when reporting it to the network operator.

2.3 *Performance management*

The ONT/NT has only limited performance monitoring. Most of the performance monitoring is limited to PMD and TC layer performance monitoring. ATM cell level protocol monitoring, traffic management, and UPC/NPC disagreement monitoring are optional.

2.4 *Security Management*

For further study

3. Protocol-Independent MIB for the OMCI

A protocol-independent MIB is used to describe the exchange of information across the OMCI. This logical MIB is based on the ATMF M4 Interface Requirements and Logical MIB. It is intended to form the basis from which protocol-specific models (e.g., simple device protocol for ONT/NT) are defined. Protocol-specific MIB implementations should resemble the protocol-independent MIB as much as practical. The protocol-independent MIB should not, however, place unnecessary constraints on its protocol-specific implementations.

The protocol-independent MIB presented in this document has been defined in terms of *managed entities*. The managed entities are abstract representations of resources and services in an ONT/NT. The managed entities defined in the ATMF M4 MIB that relate to ONT/NT management are listed in Table 2.

Table 2: Managed Entities

Managed entities	**Relation to ONT/NT**
AAL Profile	Used for non-ATM UNIs
ANI	ONT/NT network-side interface
ATM Cell Protocol Monitoring Current Data	(optional)
ATM Cell Protocol Monitoring History Data	(optional)
ATM Cross Connection	ATM VP Mux
ATM NE	ONT/NT
Equipment	ONT/NT
Equipment Holder	UNI card slot
Interworking VCC Termination Point	For non-ATM UNIs
Multipoint Bridge	(optional))
Physical Path Termination Point	UNI-LT AN-LT
Plug-in Unit	UNI card
Software	software in ONU and UNI cards
TC Adaptor	TC layer on both UNI-LT and AN-LT
TC Adaptor Protocol Monitoring Current Data	(optional)
TC Adaptor Protocol Monitoring History Data	(optional)
UNI	User/network interface
VPL Termination Point	VP link termination for VP Mux
CES Service Profile	For CES service
IP Service Profile	For IP service
AAL Protocol Current Data	(optional)
AAL Protocol History Data	(optional)
UPC/NPC Disagreement Monitoring Current Data	(optional)
UPC/NPC Disagreement Monitoring History Data	(optional)
VP OAM flow profile	(optional)

3.1 Managed Entities Relation Diagrams

The relationships between the supported managed entities are summarized in Figures 5-8.

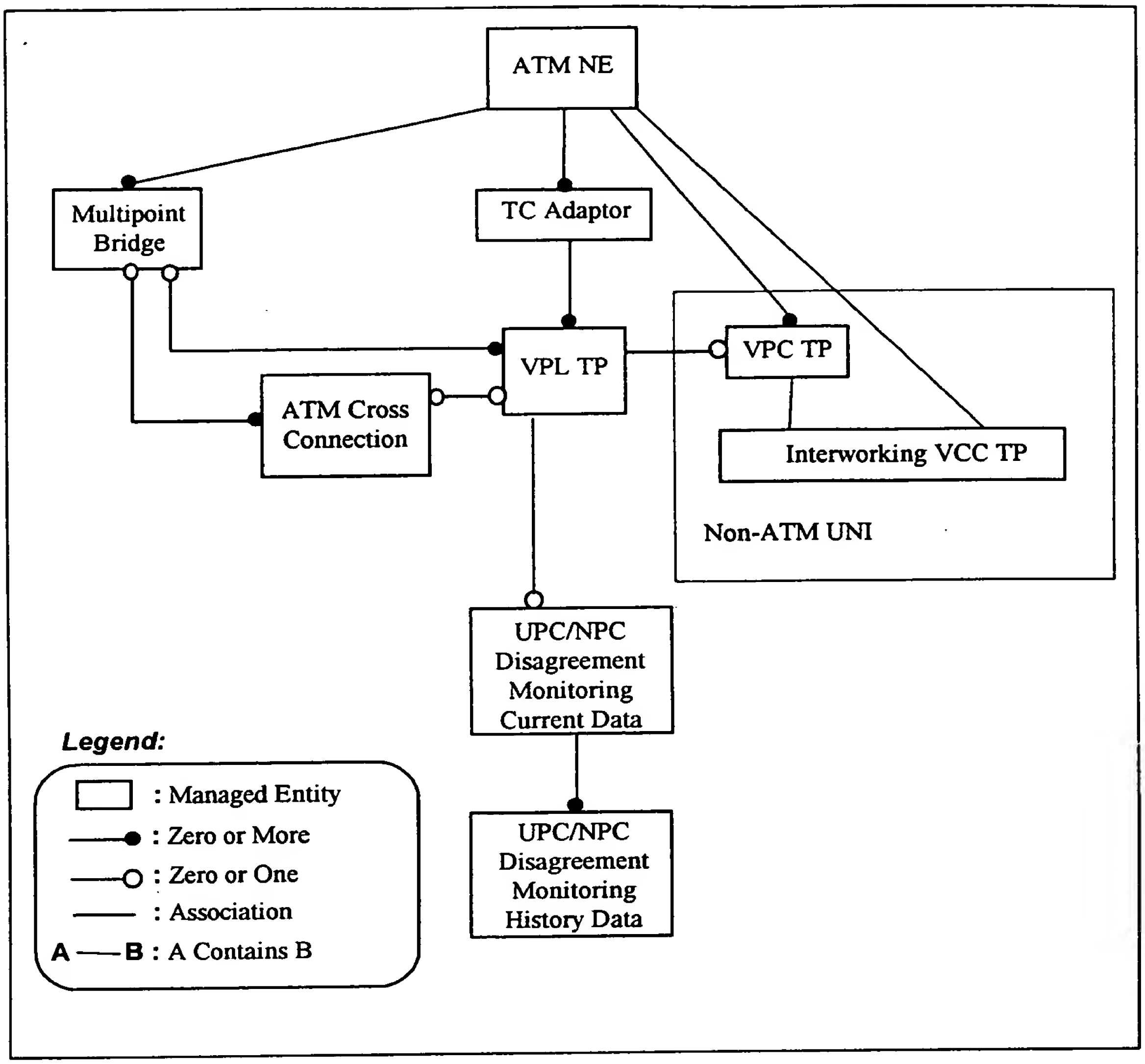


Figure 5 Managed Entity Relation Diagram (1 of 4)

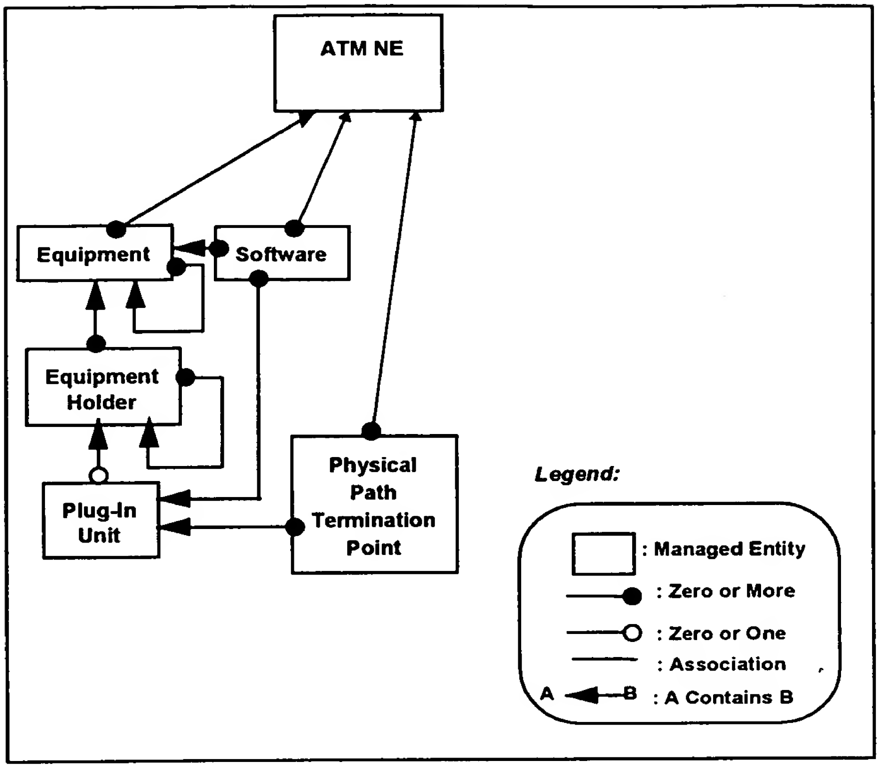


Figure 6 Managed Entity Relation Diagram (2 of 4)

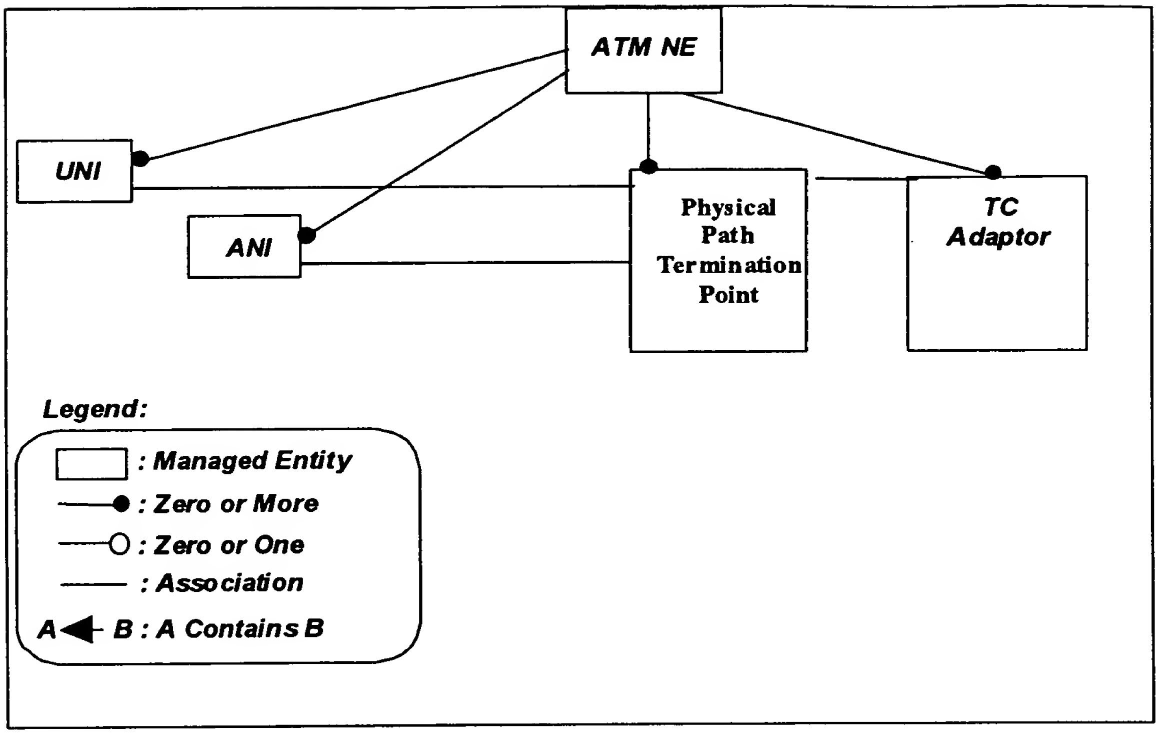


Figure 7 Managed Entity Relation Diagram (3 of 4)

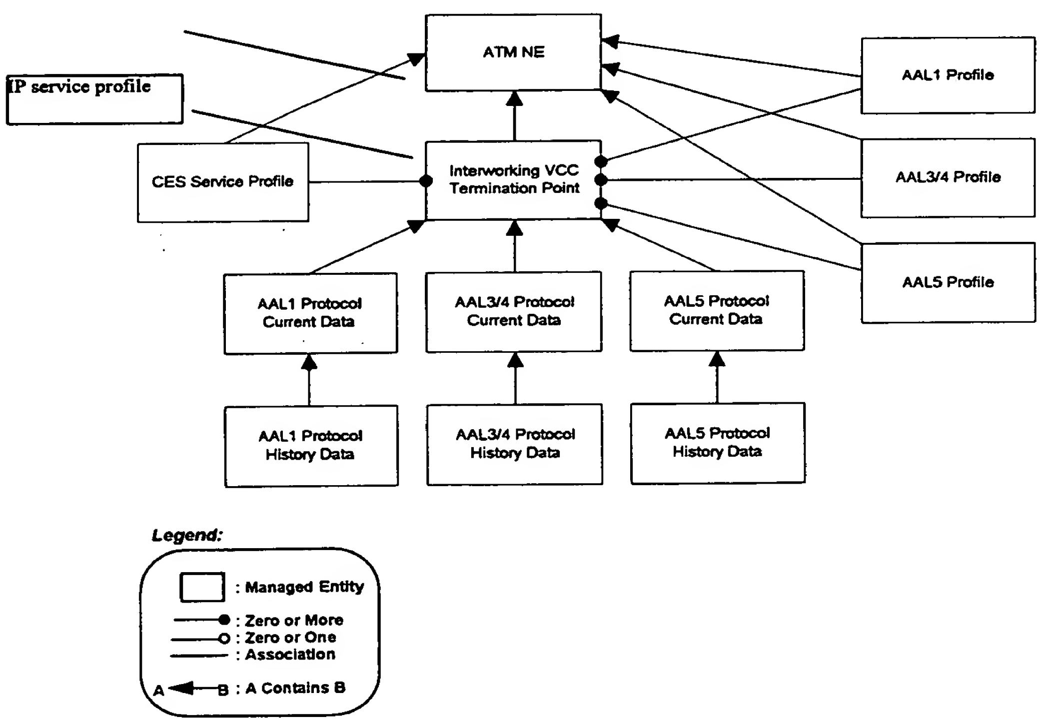


Figure 8 Managed Entity Relation Diagram (4 of 4)

3.1.1 ONT/NT Specific Management Entity Relations Diagram

Figure 9, derived from Figures 5, 6 and 7, shows the ONT/NT management entity relations. Note as an example that only ONT/NT with ATM UNIs is considered here. Within each ONT/NT there is an **ANI** and a fixed maximum number (1...NmaxpUNI) of **UNIs** that either reside on a fixed maximum number (0..NmaxUNIcard) of **UNI cards** or are integrated into the **ONT/NT**. Each **UNI** is associated with a **tcAdaptor** instance that models the adaptation of the ATM layer to the physical layer. Each instance will be associated with a fixed maximum number (1...NmaxVPL) of **VPL Termination Point** instances modelling VP link terminations. A fixed maximum number of **VP-Cross connection** instances (1...Nmax-atmVPMux) will be available for modelling **VP-Cross connections**.

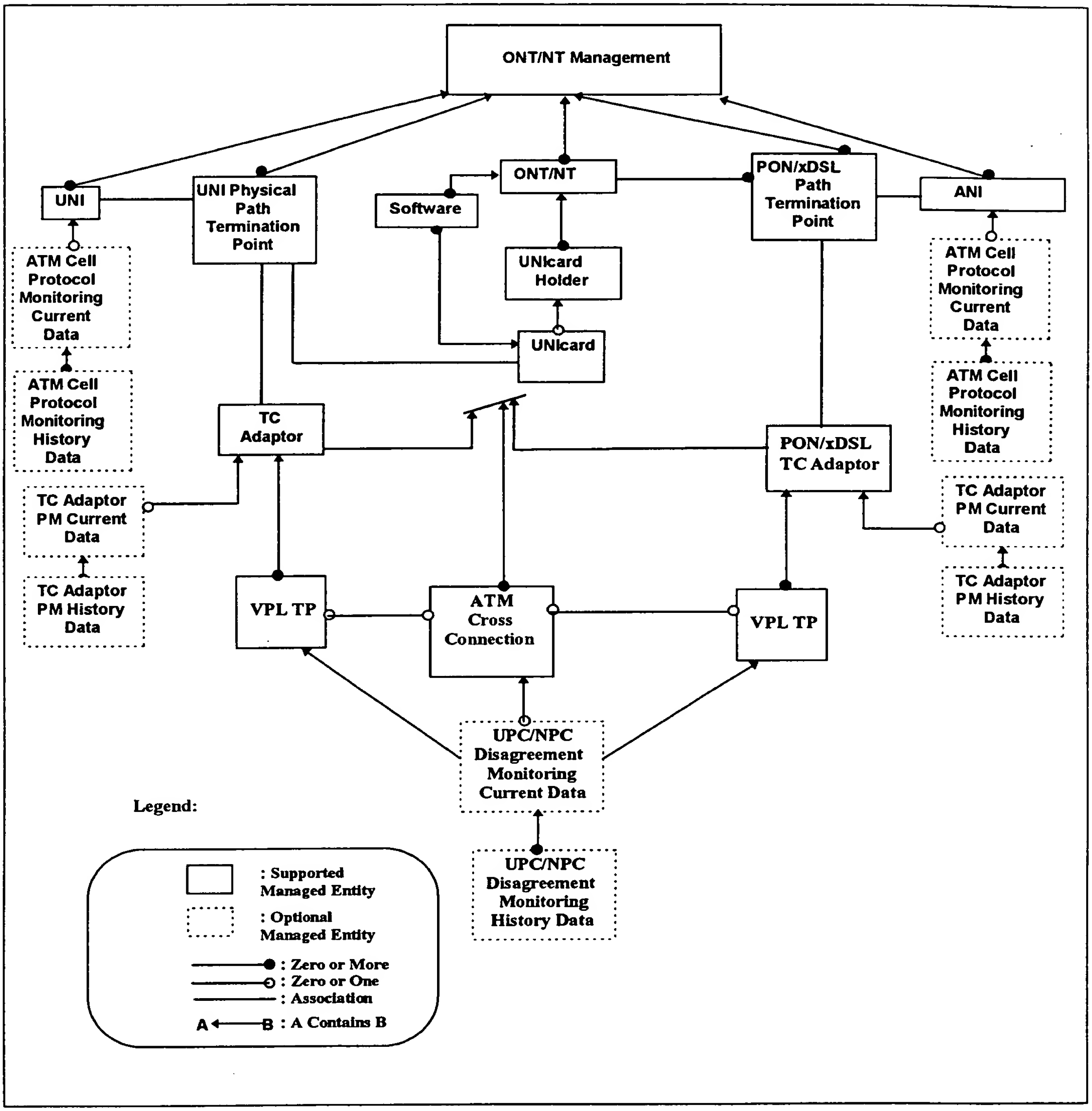


Figure 9: ONT/NT management entity relation diagram

A detailed description of the ONT/NT managed entity is provided in the sections that follow. These sections describe the purpose and attributes of each entity and are organized as follows:

1. ONT/NT equipment management
2. AN (i.e. PON/xDSL) interface management
3. UNI management
4. VP layer management

4. ONT/NT Equipment Management

5. ANI Management

6. UNI Management

7. VP MUX Management

8. ONT/NT Management and Control Channel (OMCC)

An ATM connection shall be provisioned for the OMCC. ITU-T Rec. G.983 specifies a PLOAM message that activates a VPI/VCI pair between the OLT and ONT processors. The VPI/VCI value for the management channel of each ONT is programmed by the OLT using this message. The OMCCs of different ONTs should be assigned different VPIs.

The xDSL NT uses the default value VPI=1, VCI=32, and therefore needs no provisioning, since the NT-to-ONU connection is a point-to-point link.

It is outside the scope of this document to specify how NT management information is transferred to the OLT and then to the AN management system. There are two typical options: either the NT management VP is not terminated in the ONU but routed to the OLT, or the ONU terminates the NT management VP, processes the management information from the different NTs and provides the OLT with filtered information. Several factors determine which alternative is the best fit for a given ONU. Examples of such factors are cost, security, traffic volume, ATM class of service and reliability.

The following performance requirements related to the OMCC should be studied further with input from operators:

1. The cells carrying ONT management messages should be sent with cell loss priority CLP = 0.
2. The total traffic on all the OMCCs should not exceed x (TBD) percent of the PON bandwidth.
3. The QOS parameters of the ATM connection used for the OMCC.
4. Message Response Time: The system should support Response Times that do not exceed x (TBD) seconds for 95% of the messages.

9. ONT/NT Management and Control Protocol

9.1 ONT/NT Management and Control Protocol Cell Format

9.1.1 Introduction

Each ONT/NT Management and Control Protocol packet is encapsulated directly in a single 53-byte ATM cell. It complies with the ATMF Simple Device Protocol (SDP) format, see Figure 8. The following subsections discuss the details.

ATM header (5 bytes)	Transaction Correlation ID (2 bytes)	Message Type (1 byte)	Device ID Type (1 byte)	Message Identifier (3 bytes)	Message contents, (33 bytes)	AAL5 trailer (8 bytes)
				Defined by FSAN		

Figure 8 ONT/NT Management and Control Protocol cell format

9.1.2 ATM Header:

The header contains the VPI/VCI value of the OMCC for the addressed ONT/NT, see Section 0.

9.1.3 Transaction Correlation ID (SDP compliant):

Used to associate a request message with its response message. For request messages, the OLT selects any transaction identifier. A response message carries the transaction identifier of the message to which it is responding. The transaction identifier of event messages is zero.

The mechanism which the OLT uses to assign the Transaction Correlation ID in an acknowledged command is not standardized and is left to the implementer.

However, since the Transaction Correlation ID is used to match a command from the OLT to the ONT with a response from the ONT to the OLT, some care is required in the choice of the Transaction Correlation ID. The OLT must assign the Transaction Correlation IDs in such a way that whenever it sends a command with a Transaction Correlation ID which has been used before in another command to the same ONT, it is guaranteed with sufficiently high probability that no response for the first command can be received anymore.

9.1.4 Message Type

The message type field is sub-divided into four parts:

8	7	6	5 … 1
DB	AR	AK	MT

Figure 9 Message type field subdivision

The most significant bit, bit 8, is reserved for the destination bit (DB). This bit is defined in SDP for source routing. In the OMCI this bit is always 0.

Bit 7, Acknowledge Request (AR), is used to indicate whether or not the message requires an acknowledgment.

- 1: acknowledgment expected
- 0: acknowledgment is not expected

Note that "acknowledgment" here is a response to an action request; it is not at the link layer.

Bit 6, Acknowledgment (AK), is used to indicate whether the message is an acknowledgment.

- 1: acknowledgment
- 0: not an acknowledgment

Bits 5 through 1, Message Type (MT), are used to indicate the message type. Codes 0 to 3 are reserved by the ATMF SDP specification. Codes 4 to 31 are used by this specification. Table 3 lists the message types that are defined.

Table 3. OMCI message types

Type	Purpose	Acknowledgment expected	MT value
Create	Create a managed entity instance with all its attributes	yes	16
Delete	Delete a managed entity instance	yes	17
Set	Set one or more attributes of a managed entity	yes	18
Get	Get one or more attributes from a managed entity	yes	19
Notify of an attribute value change	Notification of an autonomous attribute value change	no	20
Alarm	Notification of an alarm	no	21
get Alarm	get Alarm Status	yes	22
Test	Request a test on a specific managed entity	yes	23
Software download start	Start a software download action	yes	24
Software download	Download a section of a software image	yes	25
Software download end	End of software download	yes	26
RESERVED			27 through 30
Null	Used for data link acknowledgments	no	31

9.1.5 Device ID Type

The ITU-T Rec. G.983 OMCI protocol is identified by 0x0A in this field. Other device ID types are specified by the ATM Forum .

9.1.6 Message Identifier:

The message identifier field is 3-byte long and divided into three parts, see Figure 10.

Managed entity class identifier	Managed entity instance identifier (MSB)	Managed entity instance identifier (LSB)

Figure 10 Subdivision of the message identifier field

The most significant byte of the message identifier field is used to indicate which managed entity class is the target of the action specified in the message. The maximum number of possible managed entity classes is thus 256. The least-significant two bytes of this message identifier field are used to identify the managed entity instance. The maximum number of instances per managed entity class is thus 65,536.

9.1.7 Managed entity class identifier

Table 4: Managed entity classes in the OMCI

Managed entity class	Message identifier value
ONT/NT	1
UNI Card Holder	2
UNI Card	3
Software Image	4
UNI	5
TC Adapter	6
Physical Path Termination Point	7
Interworking VPC Termination Point	8
AAL1 Profile	9
AAL2 Profile	10
AAL3/4 Profile	11
AAL5 Profile	12
CES Service Profile	13
IP Service Profile	14
VPL Termination Point	15
VP Cross Connection	16
QoS Descriptor	17
Priority Queue Profile	18
Operator Specific	19
Vendor Specific	20

9.1.8 Managed entity instance identifier

Depending on the managed entity, there will be only one (e.g. ONT/NT) or several (e.g. VPL Termination Point) instances. Each instance is identified by its ID number.

9.1.9 Message Contents

The layout of the message content field is message specific. The detailed layouts of all the messages are given in Section 0.

9.1.10 AAL 5-Trailer

The eight bytes of this field are used as follows:

1. The CSCS-User-to-User-Indication (CPCS-UU) field is set to all 0s at the transmitter and ignored at the receiver.
2. The CPCS Common Part Indication (CPCS-CPI) field is set to all 0s at the transmitter and ignored at the receiver.
3. The length of the CPCS-SDU field is set to 0x0028 (40 decimal).
4. 32-CRC (4 bytes) as specified in ITU-T I.363.

10. Messages

11. MIB Synchronization

12. Scenarios

12.1 ONT/NT Configuration Scenario

12.2 UNI Card and UNI Configuration Scenario

12.2.1 UNI Card Provision and De-provision

12.2.2 UNI Card Insertion

12.2.3 UNI Card Removal

12.2.4 Recovery on UNI Card re-insertion

12.3 VP Cross-connection Scenario

12.3.1 VP Cross-connection set-up

12.3.2 VP Cross-connection deletion

12.3.3 VP Termination Point deletion

12.4 Software Download

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